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# 315 W Pulsed-Green Generation with a Diode-Pumped Nd:YAG Laser

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## Abstract

We have demonstrated 315 W of green output from a diode-pumped Q-switched Nd:YAG laser by intra-cavity frequency doubling using a KTP. Comparable performance was also achieved with a LBO crystal. The optimum frequency-conversion efficiency was 82%.

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## Summary

The advancements of high-power diode-pumped solid-state lasers and nonlinear crystals such as KTP, LBO, BBO, and CLBO have prompted growing interest in high-average-power green and UV generation. High-power generation of pulsed green output is important for applications such as material processing, pumping Ti-sapphire and dye lasers, and the generation of laser guided stars. Efficient green generation is also a critical step to achieve high-power UV output suitable for applications where excimer lasers are currently used. We have recently demonstrated 315 W of pulsed green output from a diode-pumped Nd:YAG laser. This side-pumped laser uses compound parabolic concentrators (CPCs) for efficient coupling of CW diode radiation into a closely coupled laser pump chamber [1] enclosing a 0.6% Nd doped YAG rod (6-mm diameter and 145 mm long). With a flat-flat short linear resonator, we also obtained a CW IR output of 515 W with an optical-to-optical efficiency of 40%.

To generate pulsed green output, we used a Z resonator and intra-cavity doubling as illustrated in Fig. 1. The laser spot size in the doubling crystal was reduced by the two-mirror telescope between the laser rod and crystal. A dual-output scheme was used to lower the green power loading in the crystal. This is especially advantageous for KTP because it reduces nonlinear absorption and thus thermal lensing. We used two AO Q-switches in the cavity for efficient cavity hold off during pulsed operation. The CW and Q-switched IR outputs are plotted in Fig. 2. The ratio of pulsed-to-CW output was typically 88–91% at a PRF (pulse repetition frequency) of 13 kHz.

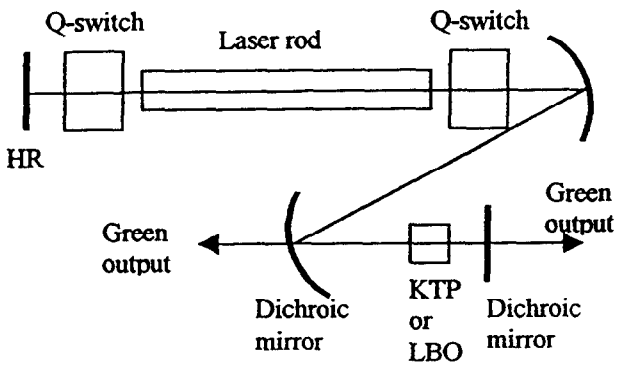


Figure 1. A Z cavity used for intra-cavity second-harmonic generation with two green output beam.

We used type-II intra-cavity doubling because of the non-polarized IR laser beam. With a 5x5x18 $mm^3$ LBO critical phase matched at 30°C, we obtained 235 W of pulsed green output at 13 kHz using a diode current of 30 A, as shown in Fig. 3. The green pulse duration was ~90 ns FWHM, which was about half of the intra-cavity IR pulse width.

We have generated green output with both flux-grown GTR-KTP (gray-tracking-resistant KTP) from Crystal Associate and HT-KTP (hydrothermally grown KTP) from Airtron. The KTP crystal size was 5x5x5 $mm^2$. The performance of a GTR-KTP was comparable to that of a HT-KTP at powers below 120 W. At higher green powers,

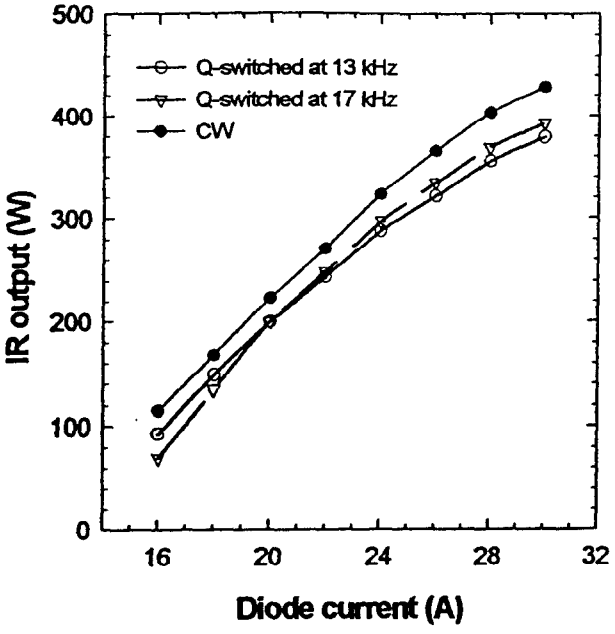


Figure 2. The CW and Q-switched IR output using a Z-resonator with a 20% output coupler.

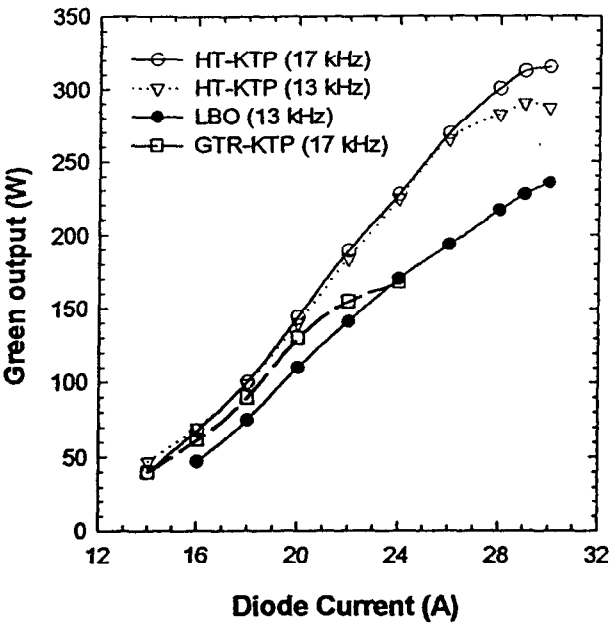


Figure 3. Pulsed green output with intra-cavity KTP and LBO at PRFs of 13 and 17 kHz.

however, a HT-KTP had superior performance than a GTR-KTP as shown in Fig. 3. A green output of 290 W was obtained at 13 kHz with a diode current of 29 A. As the PRF was increased to 17 kHz, we were able to achieve 315 W at 30 A. An optimum electrical-to-green efficiency of 8.3% and a frequency-conversion efficiency of 82% were achieved at 29 A of diode current. The green pulse duration was ~110 ns.

To our knowledge, the generation of 315 W of green output is the highest reported visible second-harmonic power generated by a single solid-state laser. This work was performed under the auspices of U.S. Department of Energy at the Lawrence Livermore National Laboratory, under Contract W-7405-Eng-48.

## Reference:

[1] J. Chang et al., "An efficient diode-pumped Nd:YAG laser with 451 W of CW IR and 182 of pulsed green output," Advanced Solid-State Lasers, Postdeadline papers pd15, 1998.

[2] G. D'yakonov et al., "High-efficiency Cr:Nd:YSGG laser with frequency doubling in KTP crystal," Advanced Solid-State Lasers, p.213, 1990.